

A LOOK AHEAD AT FARM ELECTRIFICATION

RESEARCH OBJECTIVES OF ARS-USDA¹E. G. McKibben²

First, what is the importance of farming? Of electricity? Of farm electrification?

Farming is basic to and must be a primary concern of any successful society. Everybody wants to eat everyday. We can do this in America today. This is not true in many parts of the world today. "Tonight two-thirds of the human race will go to bed hungry."³ It was not continuously true anywhere in the historical past. Will it ever be true for the whole world? How far into the future will it be true, even here in America?

Electromagnetic energy is probably the most basic form. It, or something closely related to it, appears to be the basic substance of all energy and all matter and the essential fabric of all plant and animal life.

The importance and the possibilities of the application of electromagnetic energy in its many forms to agriculture are limited only by the creative imagination and physical resources available.

Even Soviet Premier Khrushchev agrees on the importance of agriculture and of farm electrification. He has blamed Stalin's negative farm electrification attitude for some of Russia's current farm difficulties.⁴ The Economic Research Service of the Department of Agriculture concurs,⁵ stating that Soviet agriculture's consumption of electric energy in 1959 (latest figures available) was less than one-third of that in the United States.

I assume that those who set up this program hoped for some predictions. Specifically, that I would hazard some predictions concerning the future of farm electrification research in the Agricultural Research Service.

Detailed prediction about the future of any activity is impossible. Such prediction concerning the future of research is particularly irrational. Uncertainty of the outcome is the only justification for research.

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^{3/} Robert C. Cook, The Nation, January 13, 1962

^{4/} Electrical World, Page 13, August 6, 1962

^{5/} The Agricultural Picture in U.S.S.R. and U.S.A. Foreign Agricultural Economics, Economic Research Service, USDA, Page 3, July 1962.

However, I will attempt a couple of generalities.

1. Even with the support now available, there will be developments and accomplishments not yet dreamed of.
2. Any reasonable attainment of potentialities will require several times the support now available.

However, the impossibility of accurate prediction cannot excuse failure to plan. Effective planning does not necessarily require detailed blueprints of each step far into the future, but it does require (1) a realistic, acceptable long-time goal, (2) the development of more detailed short-time plans to move toward the long-time goal and (3) establishment of arrangements to initiate immediately as many actions as possible to implement the short-time plans and to move toward the long-time goal.

What is the long-time goal of farm electrification research in ARS, USDA? First, it is our firm conviction that the need for farm electrification research is more than a matter of casual use of readily available electrical equipment and generally known electrical applications as an incidental part of farm research. Therefore, we have the long-time goal of determining the most effective and economical application of as many forms of electromagnetic energy as possible to all phases of agriculture.

Possible applications include not only (1) the use of electric energy for performing and controlling field and farmstead operations, but also (2) the modification and control of field and farmstead environment, (3) the modification of the life processes and responses of farm animals, crop plants, weeds, insects, bacteria and viruses, (4) conditioning, processing and preservation of farm products, and (5) the measurement of the characteristics of these products.

We realize, of course, that this goal is rather "far-out." We believe, however, that this is the direction we should take and are working and will continue to work on the following means of moving toward this goal:

1. Maintain the best trained and most effective research staff attainable by careful selection and in-service training.
2. Arrange for the most favorable working conditions possible within the limits of available resources and existing conditions.
3. Emphasize an appropriate balance between basic and applied research, conducting both types of research by the most basic methods possible.

4. Direct research toward the most pertinent problems so far as this can be judged and working situations permit.
5. Develop one or more laboratories which will permit the concentration of a group of specialists at one location (a State Experiment Station or the National Agricultural Research Center) to focus their attention primarily on basic research.
6. Cooperate sincerely and as continuously as practicable with research workers in plant, animal and other biological sciences.
7. Cooperate with State Agricultural Experiment Stations and other public agency research groups as appropriate.
8. Cooperate with private industry insofar as resources permit and the benefits to specific research objectives indicate.

Let us take a brief look at the possibilities of applying various forms of electromagnetic energy for the purpose of modifying the life processes and responses of organisms which are important to agriculture. What are some of these forms of electromagnetic energy and means of applying them? Direct and alternating electron flow (ordinary electric current) over a wide range of voltage and many different frequencies, for the alternating current; magnetic fields with a wide range of intensity and either constant or alternating; the same for static fields; plasma (ionized gas) again a wide range of voltages, pressures and frequencies and gases; radiation using any wave length of the entire electromagnetic spectrum. The possible permutations and combinations of these are infinite.

This field of research has barely been scratched. The literature reports promising research dealing with the application of one or more of these forms of electromagnetic energy to almost every organism of importance to agriculture, farm animals, crop plants, crop seeds, economic insects, fungi, bacteria, and viruses. In some cases, the results have been positive, in some negative. However, in the great majority of cases the results have been intriguing or even promising, but not conclusive. The investigations have usually been incomplete. Relationships have not been examined over the entire range of the variables being studied or adequately replicated, usually because of lack of resources. Work has been conducted with thousands of dollars where at least hundreds of thousands were needed and would have been justified for a thorough investigation of any one of these projects.

The current concern about pesticides makes the possibility of using radiant energy to control or assist in the control of insects a timely example. The attraction of insects to light was recognized and recorded as early as 400 A.D. A light trap was described as early as 1874. Research on the use

of electric lamps for insect light traps goes back at least 35 years. For several years ordinary incandescent lamps were used. During the 2nd World War, ultraviolet lamps (so-called black light lamps) were developed. These were tried and found to be more effective for many insects.

Recently ARS, in cooperation with certain experiment stations, has been studying the response of a few insects to different bands of the spectrum. These studies have been handicapped not only by limited resources, but also by the cost and limitations of equipment to produce monochromatic radiation even for laboratory studies. For field testing of laboratory findings we have so far been limited to lamps available because they were produced commercially for other purposes. For field experiments, the best we have been able to do is to use lamps with spectrums that peak at about the wavelength found most effective in laboratory studies. Further, we find that such lamps needed to be checked from time to time because their spectral distributions may be changed without notice to meet a new or changed requirement for one of their primary commercial uses.

The need for thorough and complete examination of the relationship between variables is illustrated by results of the preliminary investigation of the response of the boll weevil to different wavelengths, note Figure 1. Exploratory laboratory tests with the spectrum in the yellow-green-blue range were made at wavelength intervals of 50 millimicrons, that is wavelengths of 415, 465, 515, and 565 millimicrons. The best response was obtained at 465 and 515 millimicrons. At these wavelengths, the response was about 60 percent. In later tests, using 25-millimicron intervals a better response of well over 70 percent was obtained at an intermediate wavelength of 490 millimicrons. How do we get a lamp which will radiate predominately at this wavelength? We have noted with interest that someone is working on the development of a blue-green laser.

However, we should not assume that a steady monochromatic radiation of 490 millimicrons is the best answer. We have not tried 480 or 500 millimicrons, combinations of wavelengths, or rythmatic variation of wavelength or intensity.

Another difficulty is the fact that research on the effectiveness of a control method which depends on attractance requires sufficient resources to set the experiment up over a very large area or on an isolated area such as an island in order to eliminate border effects. In cooperation with the Entomology Research Division, we have a project

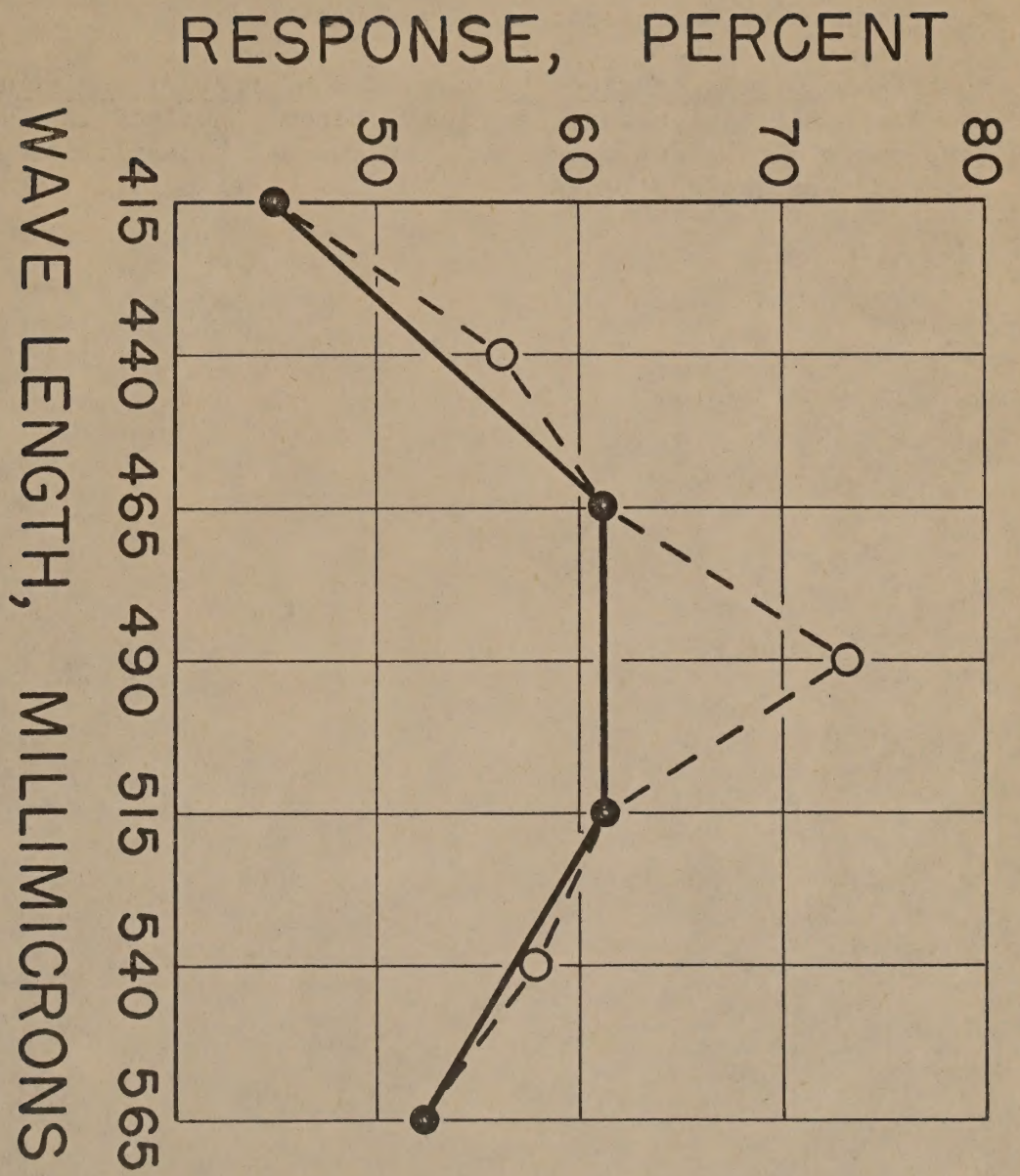


FIG. 1

on tobacco hornworms which covers a circular area twelve miles in diameter, 72⁰⁰⁰ acres. Results during the past season were rather promising, but the entomologists and engineers involved now want an island for this project. They should have it. It is needed.

What about masers and lasers? Can they be applied to insect control? Or other agricultural situations? Are there other still undiscovered forms or arrangements of electromagnetic energy as novel and as potential as these?

What about bioelectronics, bionics, and biomedical engineering? How far shall agricultural engineers become involved in such developments? As far as our imagination and capabilities are able to meet the challenge!

